

Our remarks on p. 232 appear to be justified, but detailed discussion must be deferred.

REFERENCES.

- Bruce, Sir D. (1911). "The Morphology of *Trypanosoma gambiense* (Dutton)," 'Roy. Soc. Proc.,' B, vol. 84, pp. 327—332. 1 plate.
Stephens, J. W. W., and Fantham, H. B. (1910). "On the Peculiar Morphology of a Trypanosome from a case of Sleeping Sickness, and the Possibility of its being a New Species (*T. rhodesiense*)," 'Roy. Soc. Proc.,' B, vol. 83, pp. 28—33. 1 plate. Also 'Ann. Trop. Med. and Parasitol.,' vol. 4, pp. 343—350. 1 plate.

EXPLANATION OF PLATE 3.

Various forms of *Trypanosoma rhodesiense*, drawn at a magnification of 2000 diameters. Note that some of the short and stumpy forms have the nucleus posterior.

Notes on some Flagellate Infections found in Certain Hemiptera in Uganda.

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While carrying out other work at Mpumu, the opportunity has presented itself of examining the Hemiptera from the surrounding country, and some interesting protozoan infections have been found. The group has a certain importance in this connection in that it includes the two parasitic genera, *Cimex* and *Conorrhynus*. *Cimex* has fallen under suspicion in regard to kala azar, and a species of *Conorrhynus* is definitely incriminated as the transmitting agent of the South American trypanosomiasis. Certain non-parasitic species, generally belonging to the group of the Reduviidæ, occasionally attack man. An instance of this has been reported by Dr. H. L. Duke from the neighbourhood of Mpumu. He has on several occasions been bitten by a hitherto unrecorded species of *Henicocephalus*. Cases of this kind are also known from other parts of Africa, and from India. It is, therefore, not without interest to obtain some knowledge of the Protozoa infesting Hemiptera generally, and more especially of the flagellates.

So far as I am aware none of the species dealt with here are known to attack man or other vertebrates.

The parasites considered belong almost exclusively to the herpetomonad or crithidial type. I do not propose to attach species names, as the cycles have not been worked out, and the nomenclature is already in a very confused state. There is at present some considerable difference of opinion as to what is the correct name of the genus, and as none of the literature is accessible this question is not touched upon at all. In every case the specimens I have examined show a single broad flagellum, and I have used the term herpetomonas to describe all forms without an undulating membrane, crithidia for forms with a membrane, and with the kinetonucleus anterior to the trophonucleus. The word crithidia is not used in any generic sense but simply as a convenient term to denote flagellates showing the above-mentioned relation of membrane, kinetonucleus and trophonucleus.

Several of the insects examined have, as will be seen later, shown a confusing range of forms, whose real connection cannot be ascertained with any satisfactory degree of certainty by the mere examination of a relatively small number of natural infections. There is, therefore, every reason why species names should be withheld until these points are settled beyond doubt.

All the material was fixed by the wet method, using Schaudinn's fluid, and stained either by Heidenhain's hæmatoxylin or by Mayer's hæmalum.

Leptoglossus membranaceus Fab. (I) is a common Uganda species; it feeds on a certain gourd-like creeper, showing a marked preference for this particular plant, and is hardly ever found except in its vicinity. The specimens are frequently infected in the gut with a long slender herpetomonas, figs. 1-7 give an idea of its general characters and appearance. The gut forms range from broad sac-like creatures with a short flagellum (fig. 7) to long slender forms with a flagellum of great length (fig. 1). The nucleus in the broad forms is of the type so common in trypanosomes and many other flagellates, and is made up of a large karyosome surrounded by a clear space, the outer limit of which is marked off by a delicate membrane; between the karyosome and the membrane there pass fine radiating strands. In the more slender forms there is to be noticed a lengthening out of the nucleus and a tendency for the karyosome to fragment (figs. 2 and 3). Finally, in the very long types, the nucleus is drawn out into a very narrow and much elongated oval, the karyosome being represented by a row of chromatin blocks of slightly irregular shapes (fig. 1). I have not been able to detect any sign of the fine strands between the karyosome and the membrane in this phase of the nucleus. The body of the long herpetomonads is markedly flexible, which is a somewhat unusual feature in parasites of this type.

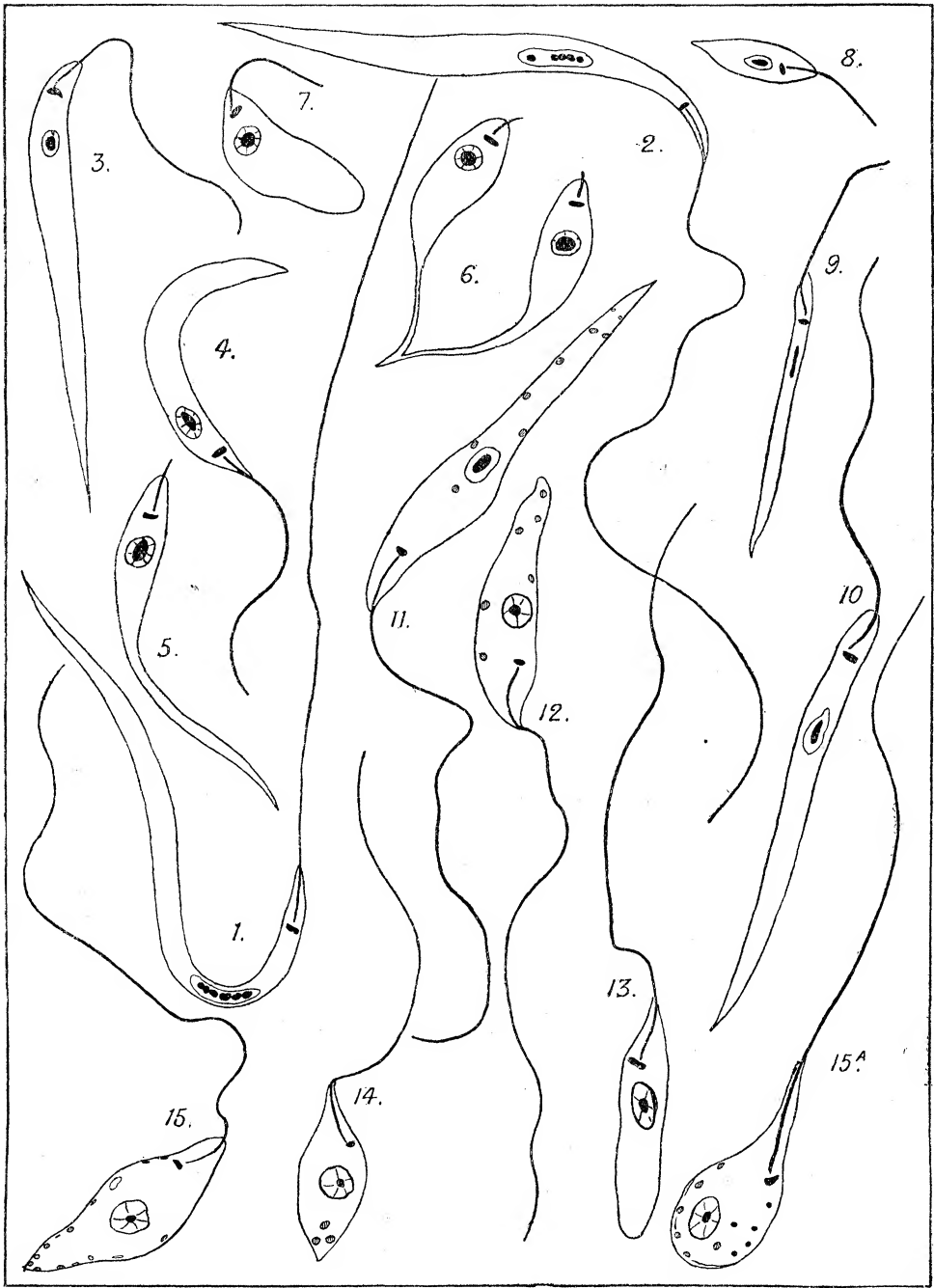
Although there is no direct evidence as regards the sequence of forms in

the material handled, there is little doubt, from all the work done on this type of protozoon, that the long slender creatures may be regarded as the adult individuals, and that they have been produced from the smaller broad forms. In all the infected specimens of *Leptoglossus* so far examined, I have not come across any of the curious crithidial forms which are so characteristic a feature of two types of infection to be discussed later.

Quite the most important point in the infection of *Leptoglossus membranaceus* is the fact that, in adult specimens, the salivary glands are very frequently strongly infected with the flagellates. Young specimens show the parasites only in the gut, and, as in the histories of most parasitic flagellates, the infection seems to work forwards, from the hinder part of the gut near the Malpighian tubules. The flagellates are not present in large numbers in the anterior part of the intestine in any of the specimens so far examined. The individuals seen in the salivary glands show a considerable range of shape and size, and curious small forms are present in fair numbers. It is not proposed to enter into these relations in detail, as this herpetomonas will, I hope, be the subject of more systematic study later on.

In the infection of the salivary glands of *Leptoglossus*, we have the independent development in a sucking insect of all the factors requisite for the transmission of a flagellate, parasitic in the intestine, by way of the mouth-parts of the insect host. This is a significant step in the history of how the complex interacting circumstances which we now find in operation in such diseases as trypanosomiasis, kala azar, and malaria may have arisen in nature. I have not so far found the parasite in the plant, but this part of the work has not been carried anything like far enough as yet to permit of a statement being made in regard to the point. These conditions in *Leptoglossus* are not at present of the slightest practical importance, but I should like to point out that it has a certain interest to find this state of affairs in Uganda involving a parasite of the same genus as that which produces the diseases of kala azar and Oriental sore.

Leptoglossus occasionally shows an infection with a coccidian, which I do not propose to describe, but there is one point that bears on the matter under discussion. This coccidian also invades the salivary glands, but probably does it by way of the body cavity. Cysts containing sporozoites were found in the salivary gland and in the gut, as also all the stages of schyzogony or asexual multiple fission. Motile, sickle-shaped individuals were found in the proboscis: morphologically, there is nothing in the live state to distinguish sporozoites and young merozoites; the probability is, however, strongly in favour of their being merozoites. I am inclined to think that the presence of these forms in the proboscis has no significance in



the coccidian cycle, but here again the condition is not without its reference to the question of the phylogenetic development of parasitic protozoa. The close relationship between the *Hæmogregarinæ* and the *Coccidia* is now well established, not to mention the general parallelism in all essential features between the cycle of the malarial organism and that of any typical coccidian. Not to lay undue weight on these points, the main feature here, as in the previous instance, is the arrival of an intestinal parasite in the mouth-parts of a sucking insect, which is, however, still a plant sucker.

The concurrence of the flagellate and coccidian parasites in the *Leptoglossus* and the fact that they have reached the salivary gland in both cases is rather striking in view of the frequent association of flagellates and *Hæmogregarines* in the blood stream of vertebrates.

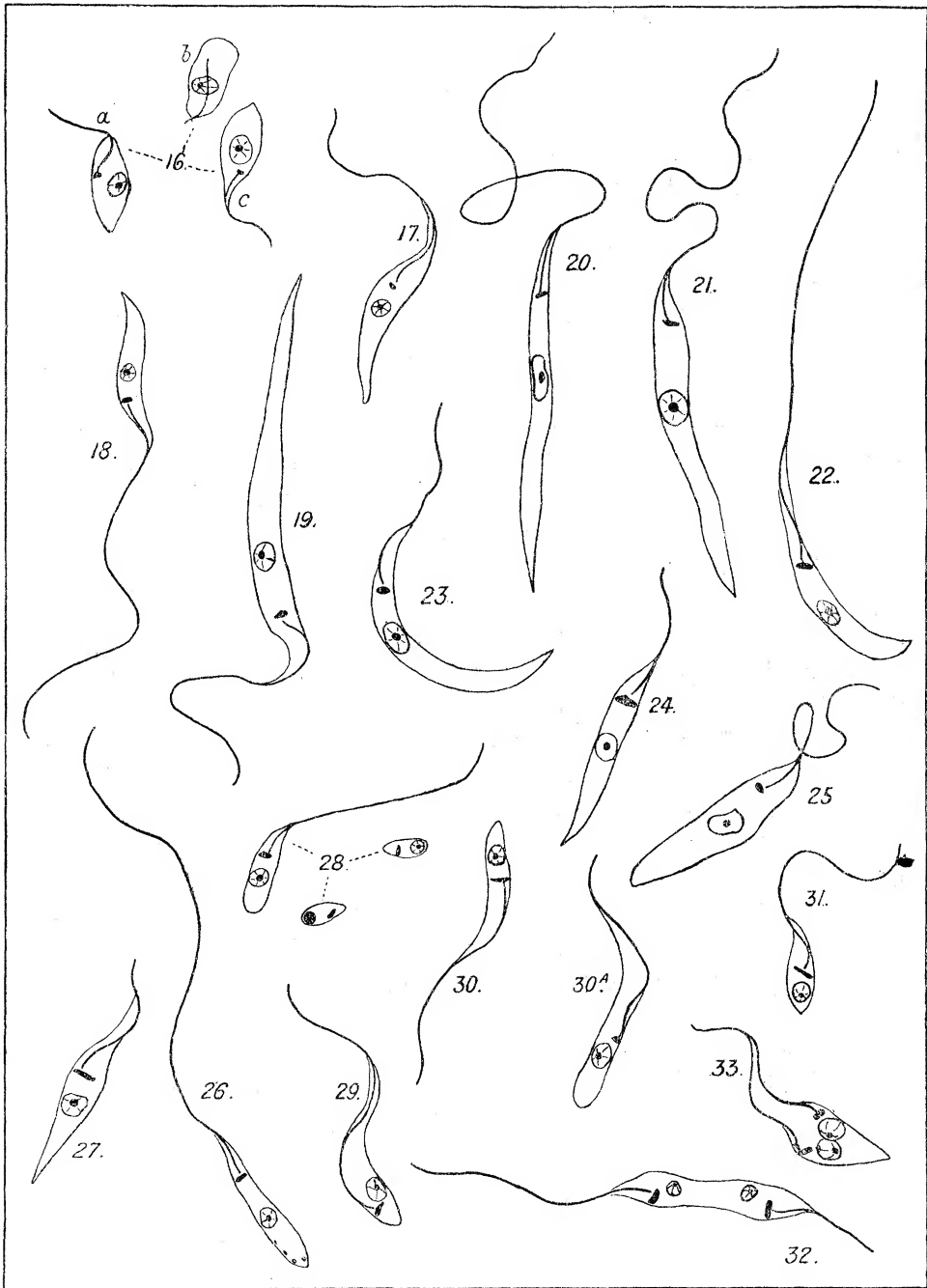
Dysdercus casiatus (XIV), the red cotton-bug, shows an occasional infection with a typical herpetomonas; so far the parasites have only been found in the gut. Only a small number of infected specimens have been examined, figs. 8-10 show the general characters of the parasites; no crithidial forms have been found in these infections.

Carbula jipensis (X).—This small bug shows rare and generally slight infections with a herpetomonas.

Two sets of infection (one in a reduviid XV, the other in a capsid bug V) now come to be considered which differ from those hitherto handled in that crithidial forms are present in large numbers as well as the typical "needle-and-thread" herpetomonads and the broad forms from which they spring. It is almost impossible to come to a really satisfactory decision as to whether there are two different species present or whether all the forms represent different stages of one species. I am inclined to consider, however, that in each of the two cases one is dealing with a single parasite, and that the crithidial forms, though sometimes present in large numbers, are more or less transitory growth forms, and that the slender herpetomonads (11, 20, and 21) are the adult individuals. Nevertheless the opposite view could be so well defended and has so much in its favour that it must be considered as practically an open question until more evidence is to hand.

The facts that, in my opinion, weigh the scale in favour of one species in which the long herpetomonads are the adults and the crithidia transitory growth forms are as follows, and apply equally to either of the two sets of infections :—

1. The herpetomonad infections are sometimes found unaccompanied by the crithidial forms, but the converse has never been observed.
2. The crithidial forms are generally present in strong, actively multiplying infections.



3. The crithidial forms merge into the herpetomonad types.

The appearance of the crithidial forms is probably due to the rapid growth of the flagellum, which is finally very long, causing the displacement of the kinetonucleus. The flagellum is in any case attached to the periplast for part of the way, and the development of the membrane in these forms is never more than a very narrow ridge of periplast along which the flagellum runs. It looks as though when the body lengthened out this uneven growth were compensated and the herpetomonad type was reached, partly by the drawing out of the posterior end of the body, and partly by the moving forward again of the kinetonucleus.

Many herpetomonad infections show this confusion of types, for instance that of the house-fly in Europe and also in India. No work has been done on these forms which has clearly shown the connection of these various forms one with another. In the house-fly the difficulties in the way are very great, and the life-histories of herpetomonads seem to be in need of further study. It is hoped that the form in *Leptoglossus* may be worked at in greater detail, as this bug breeds readily in captivity and is easily fed.

The first of the infections just discussed occurs in a bug belonging to the family of the Capsidæ (V); it is found in or near forest and is of the same light brown colour as the fallen leaves on which it runs. Its food is not known and it is apparently not a very common bug. Figs. 11-19 illustrate the main types found in this infection.

The second of these infections was found in a red and black reduviid (XV) which has not as yet been identified. It is a common species and feeds on small bugs and on other insects; the specimens are frequently infected, but I have not so far found any showing the flagellates in the salivary glands. The herpetomonas is small in size, and some of the infections, notably those in which the crithidial forms are numerous, show large numbers of small rounded forms without a flagellum. Figs. 20-33 show the features of the parasite more clearly than any mere verbal description.

I am indebted to Mr. Gowdey, the Government entomologist, for kindly identifying the species named.
